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SureCAL™
TECHNICAL NOTES

Technical Note TN 15

Calibration of Power Splitters using the SureCAL RF Components Package

Overview:

This Technical Note describes calibration of power splitters utilizing adapter substitution techniques implemented within the RF Components Package.

Adapter Handling Techniques:

In vector network analyzer measurements adapters are normally handled using one of three possible methods:

- Adapter Removal
- Adapter Characterization
- Adapter Substitution

Each method has .benefits and drawbacks. While providing the best uncertainties, adapter removal and adapter characterization techniques require additional operator activity and may not be supported by all network analyzers. While providing the higher uncertainties, adapter substitution provides maximum ease of use. Since adapter substitution requires equal length calibration kit adapters if the calibration kit is supported it can be implemented.

In the initial release, the SureCAL RF Components Package supported only adapter substitution techniques.

System Calibration:

Vector Network Analyzers primarily operate as an error corrected system. To be effective in this configuration, calibration with known artifacts is required.
The measurement cycle begins with an insertable calibration. A two port insertable calibration assumes opposite sex or sexless connectors on each port.
Once this calibration is established, it is imperative the length of each reference plane is not changed. Changes to the connectors from this point on can only be implemented by substituting an adapter of equal electrical length. Failure to

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maintain this reference plane will introduce large errors in both phase and magnitude measurements.

Implementation of adapter substitution techniques is aided enormously by using high quality cables designed specifically for VNA applications. For measurements 18GHz and less, 7mm connectors provide the maximum flexibility. Most calibration kits operating in this frequency range contain a set of compatible equal length adapters specifically for this function. The sexless 7mm connector allows the adapter substitution process to be performed without any special considerations prior to beginning.

Note! - For connectors such as 3.5mm and 2.4mm, a Male/Female adapter will need to be inserted and accounted for in the calibration process. This typically will occur at the end of the Port 2 cable. Once it is accounted for in the calibration, it can be substituted with an equal length adapter as required for mating with the UUT.

The process begins by performing a full two port insertable calibration. For all power splitters a sliding / fixed load calibration is recommended. The VNA Port Details tab describes the connector type and sex ultimately required for compatibility with the UUT ports.

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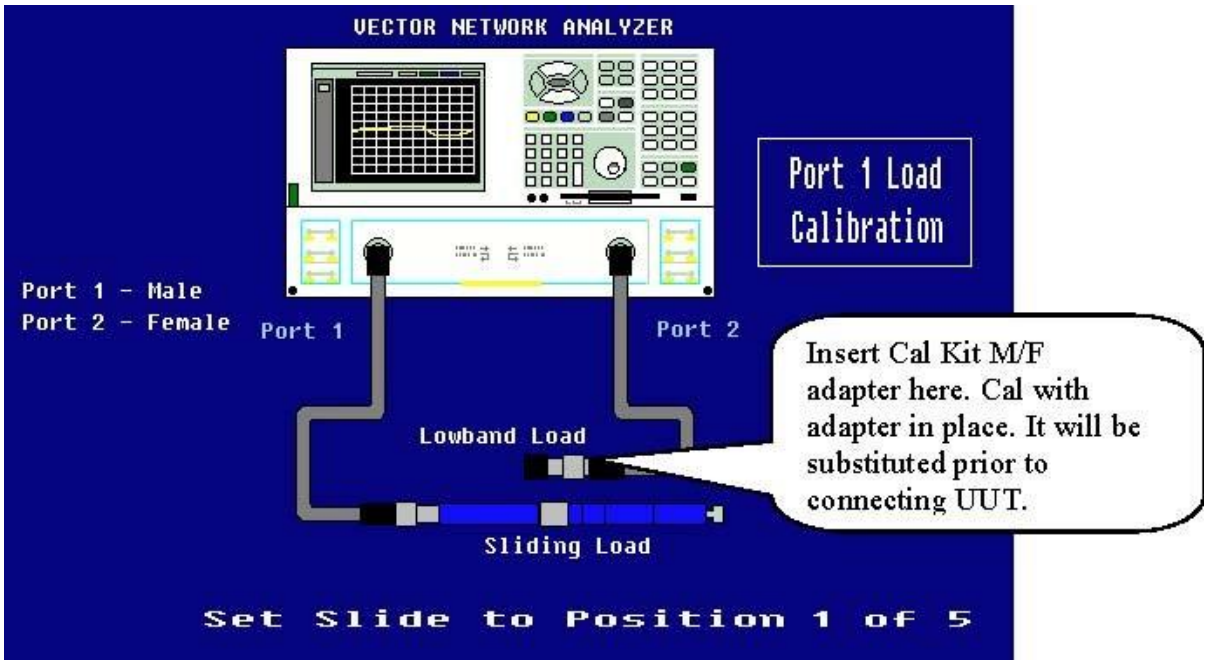
Step 1-Sliding Load Calibration:

All Fixed/Sliding Load calibrations in the RF Component Package routines begin with the sliding load. The order is designed for compatibility with all of the VNA's to be supported. The Port 1 & Port 2 connector sex is also identified for the calibration that will follow.



The sliding load calibration is applicable for frequencies above 2GHz.

This process will be repeated until all five of the required slide settings are measured. It will then repeat for Port 2.

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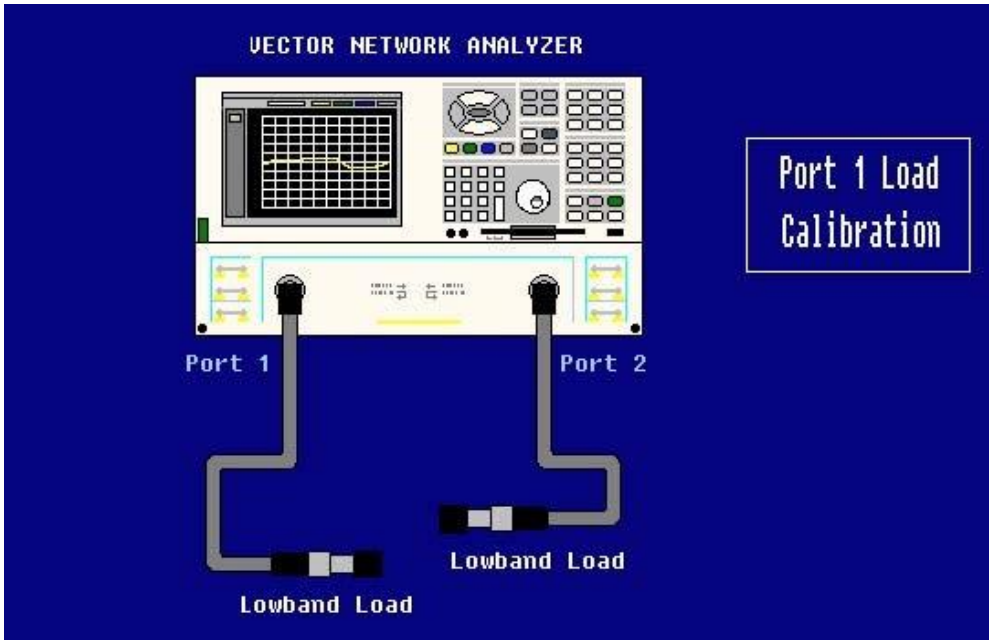
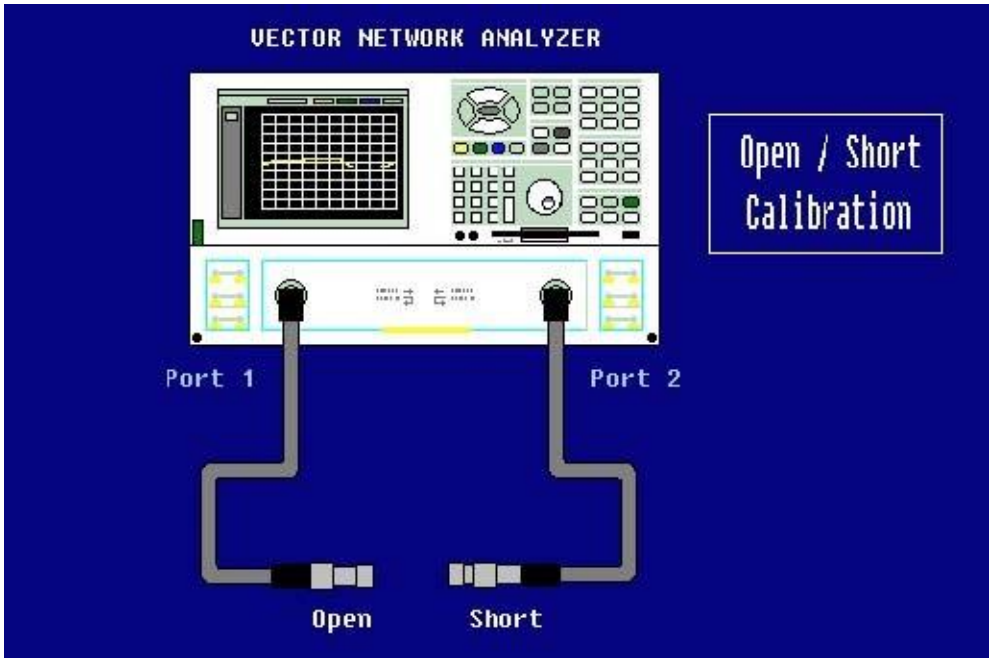
Step 2-Fixed Load Calibration: Fixed load calibration is applicable for frequencies below 2GHz.



Step 3- Open/Shorts Calibration:

The device & order are selected for compatibility with VNA's and Calibration Kits supported.



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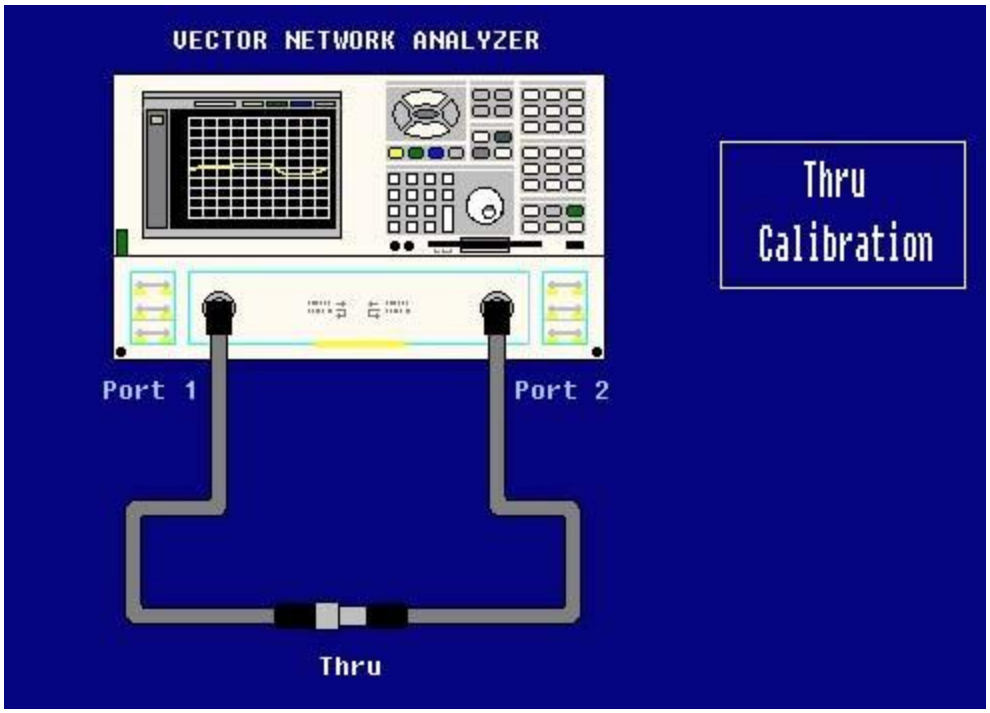
Step 3- Thru Calibration:

The final step in the calibration process is the thru. It is handled as an insertable thru. No additional devices are used.



The reference plane length has now been established. Any configuration changes for accommodating connector sexes can only be achieved by substituting equal length adapters.

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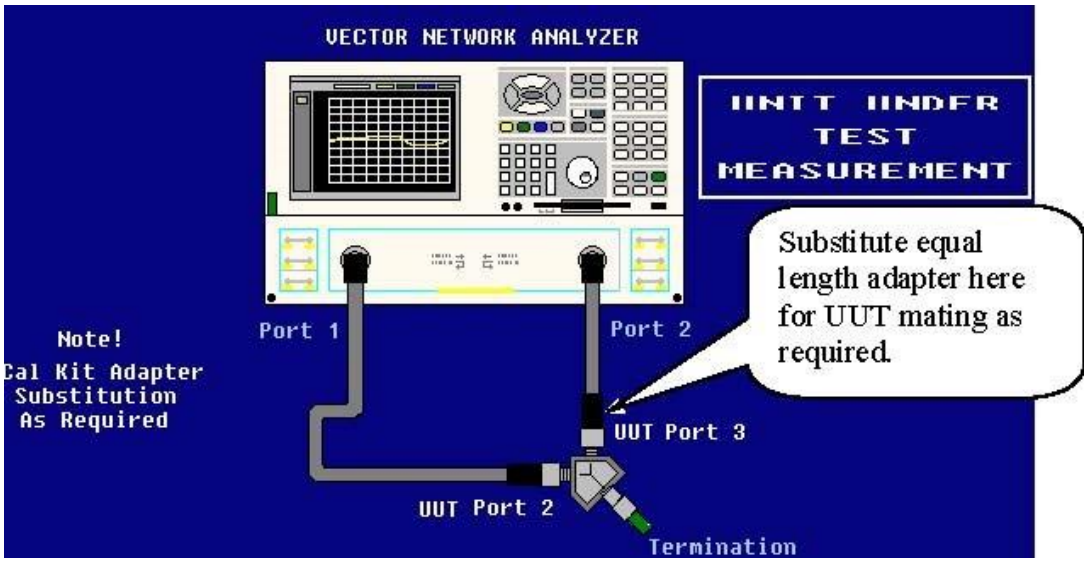
Step 4 – Measuring the Device

At this point we will focus on the configuration for the Source Match measurement. The measurement configurations for Port 2 and Port 3 are identical and no operator action is required between the steps.



We will need to substitute a male adapter in place of the female adapter used for calibration. The point of the adapter substitution is identified in the graphic below.

Measurement Details:

Determining source match requires several steps measuring both real and imaginary number pairs. First a new thru plane will be established with the UUT inserted. Depending on the port being measured, S11 and S22 are then measured with respect to this reference plane. These real and imaginary numbers are used to calculate the source match.

Summary:

If the use of metrology grade, equal electrical length adapters is strictly adhered to, the adapter substitution method can provide reasonable uncertainties with minimal operator implementation requirements.